Characteristic of a digital correlation radiometer back-end with finite wordlength

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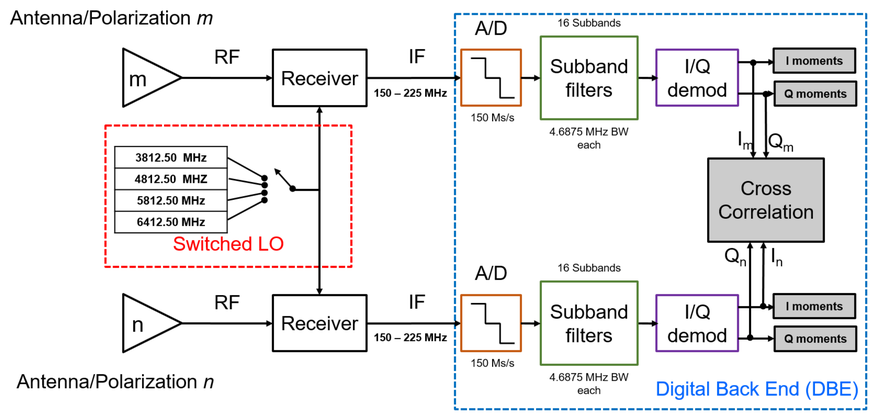

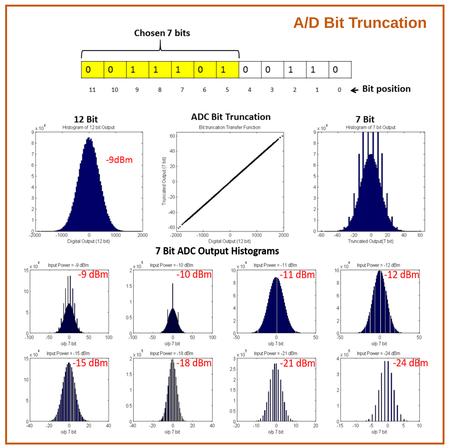

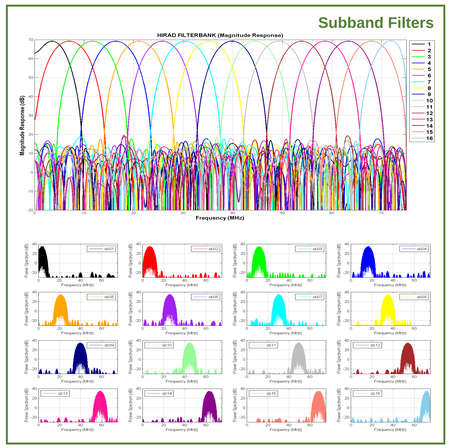

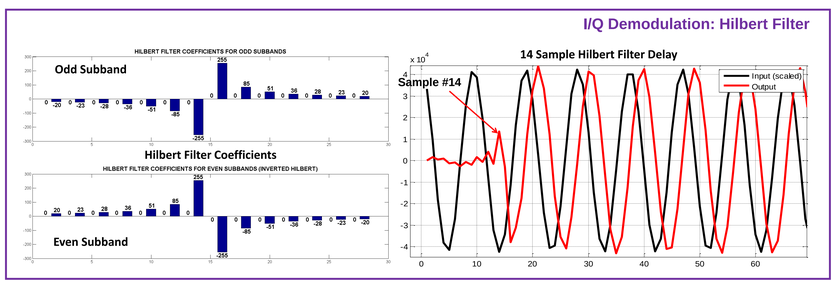

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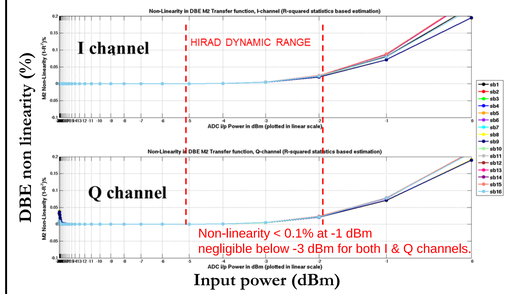
1. Introduction

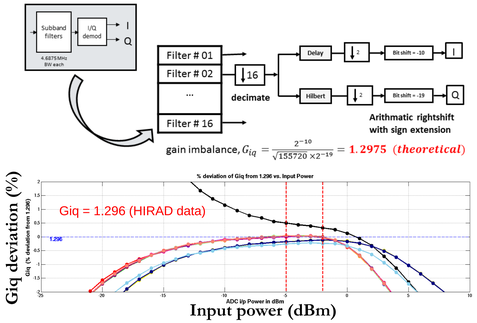
- Digital Signal Processing offers many practical advantages in microwave radiometer systems
  - interferometric, polarimetric and/or spectrometric measurements
- Typically include: A/D converter, Filters, I/Q demodulators, moment computation etc.
- Error Sources: Quantization, Hilbert filter ripples, bit truncation/finite wordlength
- A simulator is developed to predict end-to-end performance

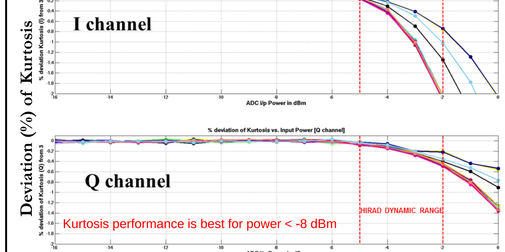
Digital Back End (DBE) Details (Based on Hurricane Imaging Radiometer)

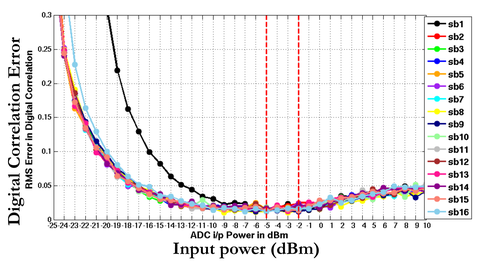
ADC	▪ 150-225 MHz IF signal, sampled @ Fs = 150 MS/s with 12 bit resolution ▪ 7 bit selected using arithmetic right shift with sign extension
Subband Filter	▪ 16 bandpass FIR filters, BW = 75MHz/16 = 4.6875 MHz ▪ Filter order: 64, input/output: 7/22 bit, filter coeffs : 9 bit ▪ Output subsampled @ Fs/16; Even subband spectral flip
Hilbert Filter	▪ Order 27, running @ Fs/16 = 9.3750 MS/s ▪ input/output: 22/35 bit, filter coeffs : 9 bit ▪ Output subsampled by half (4.6875 MS/s) & 7 bits selected
Moment/ Cross-Corr.	▪ Computed using 7 bit words

2. Simulation Results



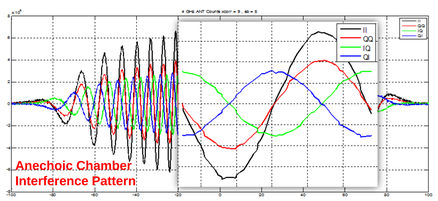


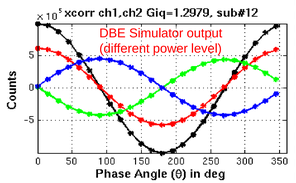


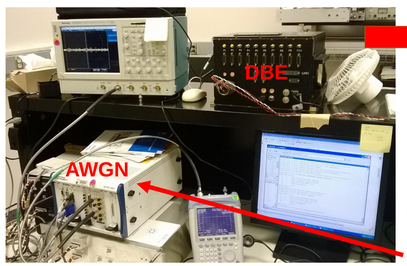


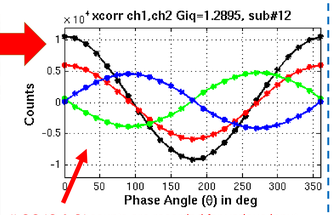
3. Lab Tests

(a) Cross-correlation







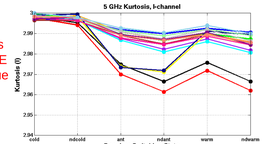


II,QQ,IQ & QI counts are recorded for various input correlation

Correlated noise generated using Arbitrary Waveform Generator (AWGN)

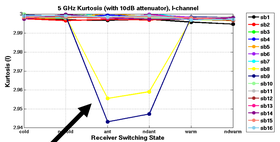
(b) Kurtosis

5 GHz Kurtosis for various DBE input power due to receiver switching

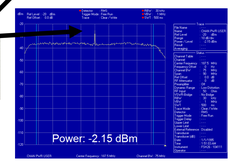


With -10dB attenuator

Improved Kurtosis sensitivity!



5 GHz WiFi Interference



4. Summary

- Performance of a radiometer DBE is analyzed. The particular design corresponds to the DBE of the airborne Hurricane Imaging Radiometer
- A computer simulator is developed to analyze effect of input power on various DBE output products
- 2nd moment non-linearity is found to be negligible in the expected input signal dynamic range
- Observed scaling between I and Q channels and the scaling among cross-correlation signals are verified by the simulator
- Kurtosis sensitivity can be improved by lowering the input power – predicted by the simulator and verified in the lab